

# *PRESSURIZED DRUMS, What Every Handler Should Know*



Louie Sferrazza  
President  
EET Corporation

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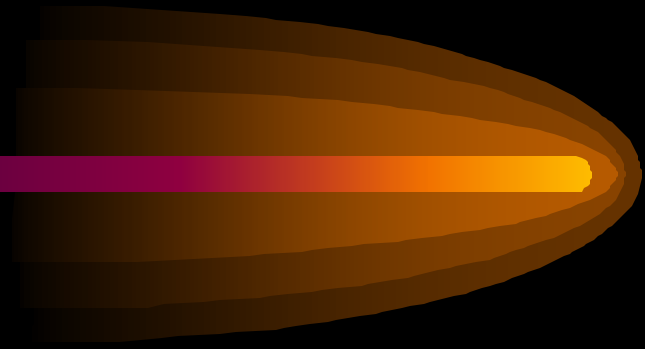
# *Routine Drum Management Activities*



- storage
- handling
- sampling
- shipment
- waste treatment

*Many of these require drum opening.*

# *Drum Opening*



- a controlled, routine duty, or
- a moment of violent pressure release that can lead to serious injury, even *death*, and spread of contamination to personnel and the environment

# *Drum Opening: Potential Deadly Projectiles*



- when released from a drum with internal pressure, the drum lid and retaining ring from an open-head type drum can become fast-moving projectiles
- if the handlers removing the lid or bystanders are in the path of these projectiles, serious injuries or even *death* can occur

# *Drum Opening: Potential Spread of Contamination*



- release of an open-head type drum lid under pressure may cause the contents to be sprayed out of the drum
- the handler and surrounding facilities may become contaminated, exposing the handlers to harmful chemicals and requiring expensive environmental cleanups

# *Reports of Injuries and Near-Misses are Abundant*

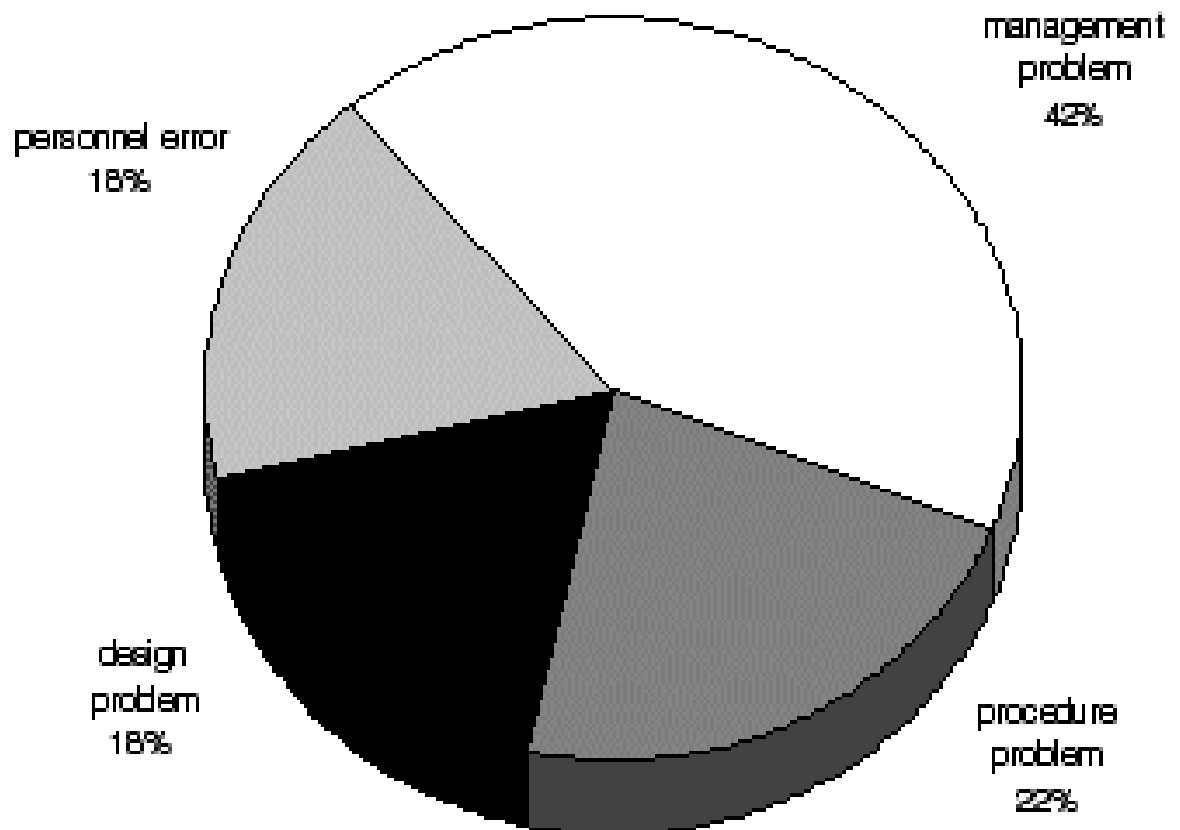


- Department of Energy - over 20 reports of injuries or near-misses, almost 200 documented pressurized container incidences from 1993 through 1999 (*Operating Experience Weekly*, <http://tis.eh.doe.gov/oeaf/>)
- most likely there were many more undocumented near misses

# *Understand Underlying Causes of Injuries and Near Misses*

## **Some Underlying Causes of Injuries and Near Misses**

- Inadequate administrative control, 44%
- Work organization/ planning deficiency, 33%
- Policy not adequately defined, disseminated, or enforced, 23%



Source: DOE Operating Experience Weekly 97-03

# *Realize that Extremely Violent Drum Lid Reactions are Possible*



- violent, extremely dangerous drum lid reactions are possible as the lid is removed, even at relatively low internal drum pressures
- violent response is due to enormous upward forces on the drum lid



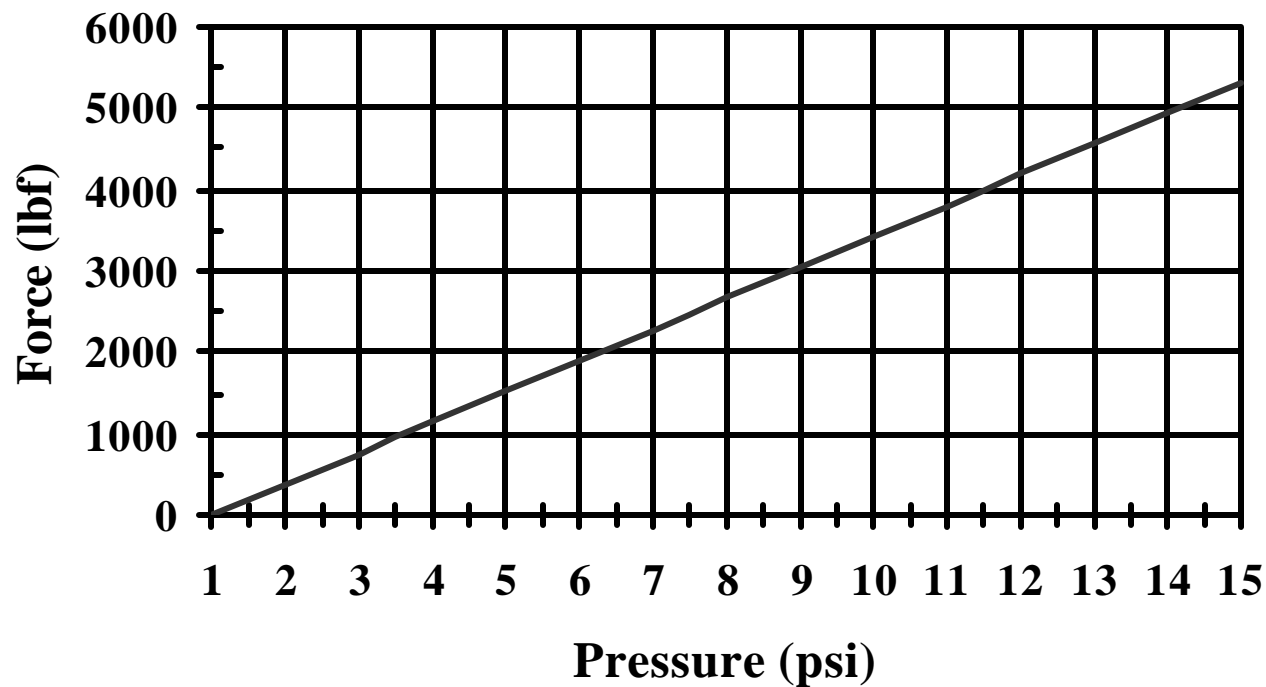
# *Lid Released from Pressurized Drum*



Video of Lid Popping Off Drum Pressurized at 8 PSI

# *Upward Force on the Lid of a 55 Gallon Open-Head Drum*

**Internal Pressure vs. Upward Lid Force for  
55G Drum**

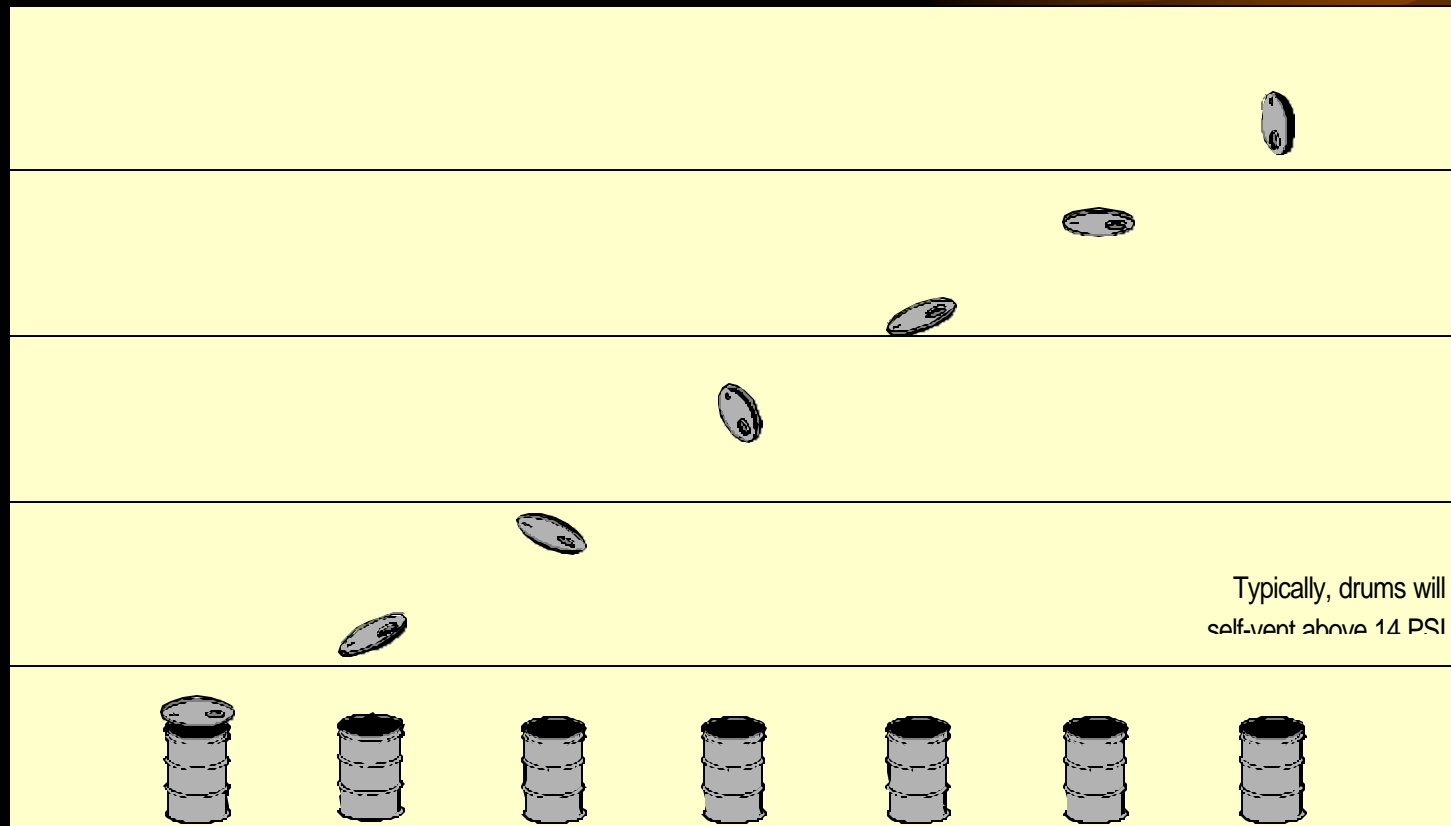


# *Response Reaction for a 55 Gallon Open-Head Drum*



Drum Internal Pressure (psi)	Drum Lid Response, Vertical Height (feet)	Initial Upward Force (lbf)
1	~2	380
2	~6	760
4	~12	1521
6	~18	2281
8	~25	3041
10	~31	3801
12	~37	4562
14	~43	5322
>14	typically self-venting	

# *Drum Lid Height Vs. Pressure*



# *Minimize the Risk*



- handling and opening drums is an inherently hazardous activity
- however, the risk can be minimized by
  - implementing a company health and safety program
  - recognizing the characteristics and evidence of potentially pressurized drums
  - employing prudent practices when opening drums

# *Implement a Company Safety and Health Program*



- a company safety and health program should be in place that ensures
  - containers are only opened after all appropriate safety & support precautions, controls, standard operating procedures, and permits are in place
  - safety & health professionals and others familiar with the contents, conditions, and background are consulted prior to opening drums

# *Implement a Company Safety and Health Program*



- all appropriate P.P.E. is decided on and used during drum opening activities
- engineering controls, such as restraints (e.g., EET's DRUM WEB or other approved device), are employed as part of the company's overall drum opening safety program

# *Recognize the Characteristics of Potentially Pressurized Drums*



- 55 gallon, open-head type drums which are potentially internally pressurized include those:
  - bulging at the top or bottom
  - difficult to depress with the lid flex test
  - having higher tone when tapped compared to a drum not under pressure
  - having contents subject to degradation, reaction, or changes in temperature/conditions



# *Bulging*



- mild steel, open-head drums will usually deform or bulge at the top and/or bottom if under sufficient internal pressure
- 55 gallon mild steel, open-head drums in good condition begin to exhibit slight signs of bulging around 6 psi of internal pressure

# *Bulging*

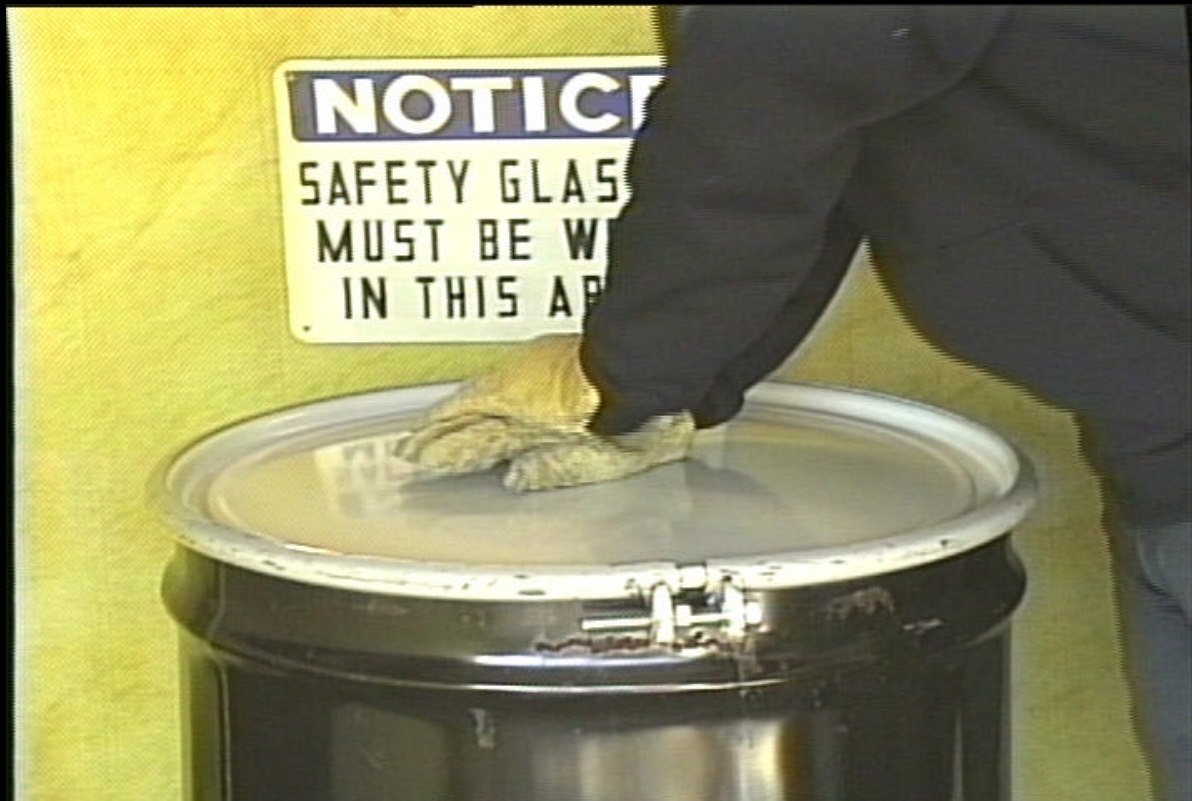


# *Flex Test*



- the flex test is performed by applying downward force to the drum lid using the palm heel
- for a 55 gallon mild steel, open-head drum
  - below 4 to 6 psi internal pressure, flex of the drum lid 1/2 inch or more is possible
  - at 6 psi and above, it is difficult to depress the lid using ordinary palm heel force

# *Flex Test*



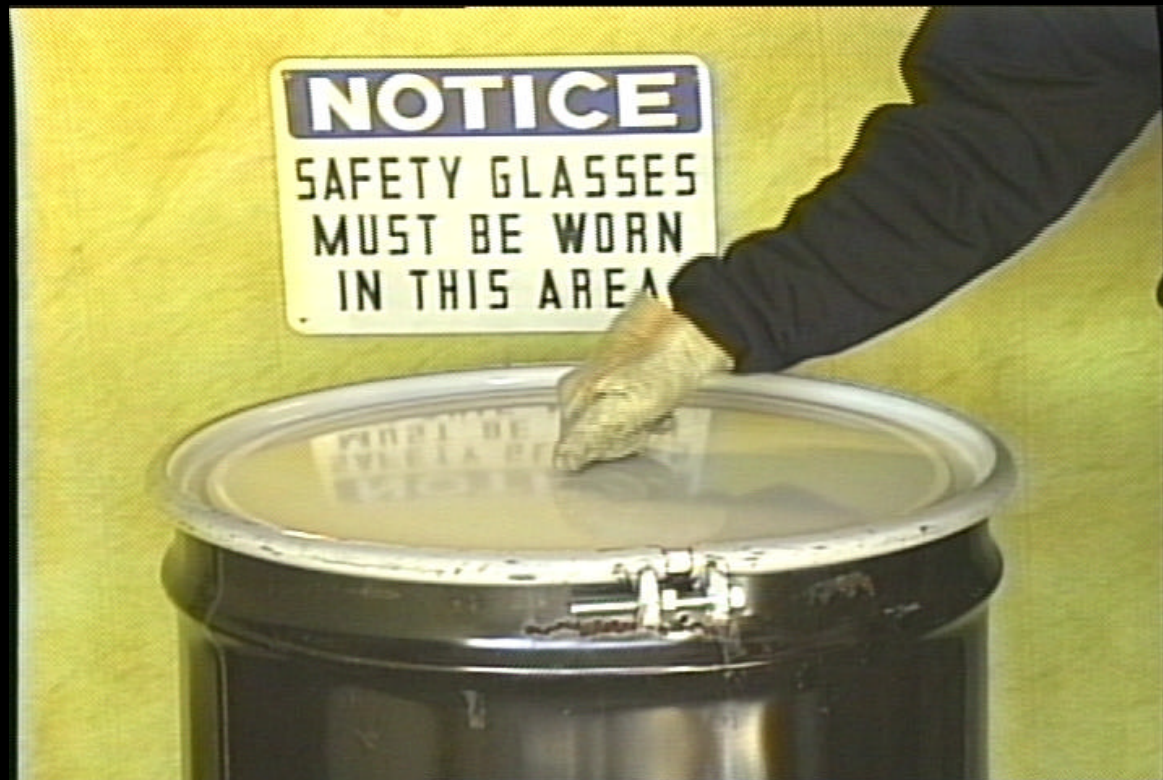
# *Differences in Tone*



- the tone produced by tapping the lid of a mild steel, open-head drum is higher than that for the same drum without internal pressure
- the tone increases noticeably with increasing internal pressure
- keep in mind some people are less sensitive to changes in pitch or tone compared to others



# *Differences in Tone*



# *Contents/Conditions that can Lead to Internal Pressure*



- internal pressure can result from
  - biological, chemical, or radiological degradation or reactions of the drum contents
  - volatilization of low vapor pressure liquids or solids
  - changes in temperature, elevation, or other storage conditions
- Safety Notice Issue No. 93-01 from DOE is excellent guide discussing contents issues  
<http://tis.eh.doe.gov/oeaf/>

# *Biological Degradation of Contents*

- biological degradation produces gases that can cause buildup of internal pressure
- contents that can be subject to biological degradation for which precautions should be employed include

Wood	Wet Soil	Vegetation
Paper and Cloth	Vermiculite	Organic Sludge
Certain Inorganic Sludges (e.g., $\text{CaCO}_3$ )	Animal Remains and Waste	Some Types of PPE



# *Chemical Reactions of Contents*



- chemical reactions of contents can produce gases and heat that can cause buildup of internal pressure
- examples include
  - corrosion of steel drums by acids, leading to buildup of hydrogen gas
  - polymerization reactions leading to heat generation

# *Radiological Degradation of Contents*




- radiological degradation of contents that results in internal pressure can occur
  - from radiolysis (breakdown by radiation) of organics, producing hydrogen and other gases
  - as a result of heat produced due to radiolysis

# *Volatilization of Contents*



- some materials (e.g., chloroform and trichloroethylene) have relatively high vapor pressures
- only slight increases in temperature can result in significant volatilization and cause buildup of internal pressure

# *Changes in Temperature or Storage Conditions*



- both empty containers and those with contents can develop internal pressure through changes in storage conditions
  - a change in storage temperature from 30 °F to 90 °F could result in an internal drum pressure of almost 2 psi
  - for a 55 gallon open-head drum, a change in elevation from sea level to Denver, CO could result in internal drum pressures over 2 psi

# *Recognize Limitations in Judging Drum Pressure Characteristics*

- drums constructed from different materials can behave far differently under the same internal pressure
  - e.g., stainless steel drums may not exhibit bulging to the same extent as a mild steel drum
- different sizes of drums behave differently
  - e.g., 30 gallon mild steel, open-head drums can contain far greater pressures compared to 55 gallon mild steel drums without exhibiting signs of bulging

# *Recognize Limitations in Judging Drum Pressure Characteristics*



- drums that do not appear to be bulging may still contain dangerous levels of internal pressure
- drums lids that can be depressed with the flex test may still contain sufficient internal pressure to be extremely dangerous

# *Non-bulging Drums Passing the Flex Test: Hidden Danger!*



# *Use Engineering Controls*

- if unsure whether a container is pressurized, use engineering controls to reduce the risk
- both webbing-based and rigid-type devices are available
- these fit over the drum, preventing the drum lid/retaining ring from becoming projectiles
- these are not for use on obviously pressurized drums, which must be remotely vented



# *Sample Engineering Controls*




EET Corporation's Drum  
Web 5585



Machine Kinetics  
Device

# *In Summary: Treat Each Container as Suspect*



- follow documented procedures and implement adequate controls
- always evaluate contents and history for potential problems
- look for signs of bulging
- perform the flex test
- listen for unusually high tone
- use engineering controls

# *Questions?*



Contact:

EET Corporation

830 Corridor Park Blvd., Suite 200

Knoxville, TN 37932

Toll Free: (888) 706-7799

Phone: (865) 671-7800

Fax: (865) 671-7779

<http://www.eetcorp.com>